United States Department of Agriculture Agricultural Research Administration Bureau of Entomology and Plant Quarantine

PRELIMINARY TESTS OF CHLORINATED BENZAMIDES AS INSECTICIDES

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One hundred and twenty-eight chlorinated benzamides were tested as insecticides in the laboratory of this Bureau at Anaheim, Calif., during the period from February 1946 to August 1948. The Division of Insecticide Investigations supplied all samples. All compounds were tested as dusts against at least three species of insects; many of the more toxic materials were tested against six or seven species. The following species were used:

Alder flea beetle (Altica ambiens (Lec.))
Armyworm (Cirphis unipuncta (Haw.))
Cabbage aphid (Brevicoryne brassicae (L.))
California oakworm (Phryganidia californica Pack.)
Celery leaf tier (Phlyctaenia rubigalis (Guen.))
Citrus red mite (Paratetranychus citri (McG.))
Green dock beetle (Gastrophysa cyanea Melsh.)
Large milkweed bug (Oncopeltus fasciatus (Dall.))
Pea aphid (Macrosiphum pisi (Kltb.))
Two-spotted spider mite (Tetranychus bimaculatus Harvey)
Variegated cutworm (Peridroma margaritosa (Haw.))
Vegetable weevil (Listroderes obliquus Klug)

The armyworm, the celery leaf tier, the large milkweed bug, the pea aphid, and the variegated cutworm were reared in the laboratory; all others were collected in the field. The equipment and methods employed were essentially the same as those described by Swingle, Phillips, and Gahan (1).

In most of the tests with coleopterous or lepidopterous larvae 24 insects were used per test, a minimum of 20 milkweed bugs were used, and the number of aphids and mites ranged from around this minimum to several times the number. The test period was usually 2 days.

When received for testing, the samples had been diluted to 25, 10, or 5 percent in pyrophyllite and generally were in good physical condition for dusting.

Materials causing mortalities of 75 percent or higher as dusts were applied as sprays to the leaves of five or more kinds of plants to determine whether they would injure green foliage. The sprays contained 25-percent material applied at the rate of 8 pounds per 100 gallons of water to green foliage of plants growing under natural conditions.

The results of the tests with insecticides of known value against certain insects, made for comparative purposes, are presented in table 1.

Data on 27 compounds that caused greater than 74 percent mortality to one or more species of insects in dust tests are shown in table 2. Of these materials 20 were effective against the two-spotted spider mite.

On the basis of the number of species affected, the four most toxic compounds appear to be p-chloro-N, N-disopropylbenzamide, 3,4-dichloro-N, N-disopropylbenzamide, 3,4-dichloro-N, N-dimethylbenzamide, and 2-phenylhydrazide-o-chlorobenzoio acid.

The first three compounds named were effective both as contact and as stomach poisons, but 2-phenylhydrazide-o-chlorobenzoic acid was not effective as a contact poison against the insects tested. No appreciable injury to foliage resulted from spray applications of any of the four compounds. Compounds reported in table 2 that did show moderate toxicity to green foliage of one or more kinds of plants were N-amyl-3,4-dichlorobenzamide, 2,4-dichloro-N-ethylbenzamide, and 2,4-dichloro-N,N-dipropylbenzamide.

Table 3 presents results of tests against various insects with 29 compounds that gave kills between 25 and 74 percent. However, the only compounds that caused mortalities of 60 percent or higher were 3,4-dichloro-N-benzylbenzamide, p-chloro-N-sec-hexylbenzamide, 2-phenylhydrazide-3,4-dichlorobenzoic acid, and 2,4-dichlorobenzoyl-piperidine against the two-spotted spider mite, 2-phenylhydrazide-p-chlorobenzoic acid against the celery leaf tier, and 2',3,4,5'-tetra-chlorobenzamilide against the pea aphid.

The compounds that caused less than 25 percent mortality of the species against which they were tested are listed in table 4.

Literature Cited

(1) Swingle, M.C., Phillips, A.M., and Gahan, J.B.
1941. Laboratory testing of natural and synthetic organic substruces as insecticides. Jour. Econ. Ent. 3.: 95-99.

Table 1. - - Effectiveness of four insectionides tested against various species of insects fed dusted follage, to be used as standards for comparing results obtained with new insecticidal compounds

| Compound | | Insect | Stage | Foliage | Feeding | Average deposit Average kill per square centimeter 2 days 3 day | t Average ki. after- 2 days 3 d | erage kill after- days 3 days |
|------------------------------|---------|-------------------------|----------------------|---------------|----------|---|---------------------------------------|-------------------------------------|
| 544 | Percent | | | | | Micrograms | Percent | Percen |
| Garma benzene hexa- | 2 | Pea aphid | 2-day-old nymphs | Windsor bean | I d | 215 | 86 | 1 |
| chloride (lindane) | 2 | Cabbage aphid | Nymphs and adults | Orange leaf | 1 | 92 | 100 | ı |
| , | • 5 | Large milkweed bug | Second-instar nymphs | Milkweed seed | - pe | 125 | 100 | ş |
| | | Pea aphid | 2-day-old nymphs | Windsor bean | 1 4 | 110 | 100 | 1 |
| | .2 | Large milkweed bug | Third-instar nymphs | Milkweed seed | ed - | 200 | 100 | 8 |
| | •25 | do. | do. | do. | 1 | 140 | 70 | 1 |
| | | Pea aphid | 2-day-old nymphs | Windsor bean | # u | 75 | 36 | ı |
| | .125 | Armyworm | Fourth instar | Barley | Moderate | 265 | 75 | -8 |
| Bis(p-chlorophenoxy)-methane | 8 | Two-spotted spider mite | Nymphs and adults | Lima bean | 1 | 185 | 8 | 3 |
| | 7 | Citrus mite | 元 8 8 | Orange fruit | 1 | 250 | 10 in 7 days | y Sy |
| | | Two-spotted spider mite | Nymphs and adults | Castor bean | 1 | 220 | ı | 78 |
| | ເລ | Citrus mite | do | Orange fruit | 1 | 295 | 100 | |
| 0,0-Diethyl-0-p- | φ. | do. | °op | do. | 3 | 170 | | 100 |
| nitrophenyl thiophos- | | do • | • op | do. | 1 | 215 | 1 | 93 |
| phate (parathion) | .1 | Two-spotted spider mite | do | Castor beam | 1 | 110 | ı | 95 |
| | | do. | 8 2 2 3 | opo | | | 50 in 4 days | 76 |
| | | • op | Nymphs and adults | do. | 1 | 140 | 8 | Œ. |
| | •025 | do. | do. | opo | 1 | 170 | ı | 78 |
| | •0125 | do | • op | do. | • | 185 | ı | 87 |
| | | | | | | | | |

Table 1. -- (Continued)

| Percent 2.5 rophenyl- | Ę | | | | 7 | 2 days 3 | ays 3 days |
|-----------------------------|--|------------------|----------------------|----------|---|-----------------|------------|
| ري دي | F | | | | Micrograms | Percent Percent | Percent |
| -[kuehdou | | Third instar | Barley | None | 235 | ı | 96 |
| | loaf tier | Fourth instar | Swiss chard | Slight | 155 | 1 | 100 |
| | Green dock beetle | do. | Dock | Much | 150 | 1 | 29 |
| Large mi | Large milkweed bug | Mymphs | Milkweed seed | 1 | 200 | 1 | 97 |
| 2 Armyworm | THE STATE OF THE S | Fourth instar | Corn leaves Moderate | Moderate | 170 | 1 | 63 |
| Large mi | Large milkweed bug | Nymphs | Milkwood seed | - | 265 | 86 | 0 |
| l Alder fl | Alder flea beetle | Third instar | Alder | Slight | 355 | 1 | 100 |
| Celery 1 | Celery leaf tier | do. | Swiss chard | do. | 300 | ı | 58 |
| •5 Alder fl | Alder flea beetle | do. | Alder | do. | 230 | 1 | 100 |
| Armyworth | F | Fourth instar | Barley | Moderate | 149 | | 1 64 |
| Cel 1form | California oakworm | do. | Oak leaves | Slight | 110 | 1 | 4 001 |
| Colery 1 | Celery loaf tier | do. | Swiss chard | do. | 230 | 1 | 96 |
| Green do | Green dook beetle | do. | Dook | do. | 150 | ı | 100 |
| Pos aphid | ud | 2-day-old nyaphs | Windsor bean | 1 | 200 | 35 | 1 |
| Jariogat | Variogated cutworm | Fourth instar | Mulva | Slight | 155 | | 100 |
| .2 Colory] | Colery leaf tier | Third instar | Swiss ohard | do. | 155 | 1 | 92 |
| | | | | | | | |

Table 2. - - Compounds causing greater than 74 percent mortality of one or more species of insects fed dusted foliage

| . 1 | 1 | | tro | 5 - | | |
|--|-----------------|--|---|---|---|---|
| Average kill after - 2 days 3 days | Percent Percent | 75 - 0 in 4 days | 20 88 81 81 81 81 81 81 81 81 81 81 81 81 | 0001 | 1 1 3 0 1 8 8 8 1 1 8 8 | 29 64 64 66 64 66 66 66 66 67 |
| Average deposit / per square centimeter | Micrograms Pe | 210 210 200 | 200 195 200 215 200 200 215 | 250 220 110 185 220 | 180 200 125 260 250 | 265 200 300 215 295 280 220 |
| Feeding | | Much | Moderate Much .s | Moderate do. phs - | Slight Moderate hs - | Moderate do. Much hs |
| Stage | | Fourth instar 2-day-old nymphs Nymphs and adults | Third instardo. Nymphs and adults Fourth instar Third-instar nymphs 2-day-old nymphs Nymphs and adults | Third instar do- do- Second-instar nymphs 2-day-old nymphs Nymphs and adults | Third instar do. Second-instar nymphs 2-day-old nymphs Nymphs and adults | Third instar do. Fourth instar Second-instar nymphs 2-day-old nymphs Eggs Nymphs and adults |
| Insect | ++1 | Celery leaf tier Pea aphid Two-spotted spider mite | Amyworm Celery leaf tier Citrus mite Green dock beetle Large milkweed bug Pea aphid Two-spotted spider mite | Alder flea beetle Celery leaf tier Large milkweed bug Pea aphid Two-spotted spider mite | Alder flea beetle Celery leaf tier Large milkweed bug Pea aphid Two-spotted spider mite | Armyworm Colory leaf tier do. Large milkweed bug Pea aphid Two-spotted spider mite do. |
| Compound | Percent | Anthranilic acid, N- 25 (p-chlorobenzoyl)- | Benzamide, N-sec-Amyl- 5 2,4-dichloro- | Benzamide, N-amyl- 25 3,4-dichloro- | Benzamide, N-sec-anyl- 25 | Benzamide, p-chloro- 25 N, N-diisobutyl- |

| 1 1 - | | | | | | | | | | | | - 6 | - | | | | | | | | | | | | | | | | |
|---|------------|----------------------|-------------------|-------------------------|-------------------------|----------------|-------------------|------------------|--------------------|-------------------------|--------------------|---------------------------|------------------|-------------------|------------------|-------------------------|-------------------|------------------|-------------------------|------------------|-------------------------|------|-----------------|--|-----------------------|--------------------|------------------|-------------------------|-----|
| artor days | Percent | | 10 | 95 | 63 | 70 | 1 | 10 | 25 | 0 | 8 | 4 | 8 8 | 67 | ı | 81 | 180 | 4 | 17 | 1 | 65 | 100 | 0 | 17 | | 3 1 | 1 | 100 | 7.8 |
| Averse kill after 2 days 3 day | Percent | ı | 1 | ı | 8 | 1 | 14 | 1 | ı | ı | ı | ı | ı | ı | 3 | 1 | ı | 1 | 1 | 79 | 1 | ı | 1 | ı | ı | 15 | 0 | 1 | 1 |
| Average decos t por square contineter | Micrograms | 310 | 250 | 200 | 385 | 325 | 250 | 260 | 220 | 215 | 325 | 23 | 265 | 220 | 210 | 250 | 250 | 285 | 220 | 200 | 270 | 310 | 3.0 | S. S |) C | 002 | 310 | 0116 | 200 |
| Feeding | | Kuch | 1 | t | Slight | do. | 1 | Moderate | 1 | 1 | Much | Slight | do. | do. | ì | ı | ı | Much | M ch | 1 | ı | ž | Kush | Moderate | Mach | | 1 | ı | ı |
| Stage | | Fourth instar | Wynphs and adults | • op | Third instar | Fourth instar | Hymphs and adults | Fourth instar | Mymphs | Nymphs and adults | Fourth instar | • op | do. | do. | 2-day-old nymphs | Eggs | Mymphs and adults | Fourth instar | • 0 p | 2-day-old nympha | Nymphs and adults | 2000 | Fourth in tar | Third instar | Fourth instar | cond-instar manis | 2-lay-old nymphs | Myaphs and a lult | do. |
| Lisoct | 14 | lelery leaf ther | | Two-spotted spider mite | Alder flea beetle | A TTO JANO THE | Cabbage aphid | Colery leaf tier | Large milkweed bug | Two-spotted spid r mite | Variegated cutworm | California oakworm | Celery loaf tier | Green dook beetle | Pea aphid | Two-spotted spider mite | do | Vegetable weevil | Colory loaf tior | Pon aphid | Two-spotted spider mite | do. | laretale weevil | Alder floa bootlo | le my lang tion | Lirks milkness bu: | Pus a nid | Two-sp tted a 11 r m to | do. |
| pura Lo | Percent | "on-anido,chloro- 25 | N-othyl- | | Terralite, o-chloro- 25 | li-1sopropyl- | | | | | | Jenisande, -chloro-4.1-25 | dit sopropyl- | | | | | | Lonzemile, p-chloro- 25 | N-1=0 ropyl- | | | | 19.1 anido, 2,4- 5 | denlero-i, h- inthyl- | | | | |

| Compound | Insect | Stage | Feeding | Average deposit per square centimeter | Aver 2 da | age kill after- ys 3 days |
|----------|-----------------------------|--------------------------|----------|---|--------------|---------------------------------|
| 0 | Percent | | | Mi crograms | Percent | Percent |
| ເລ | | | Much | 265 230 | 1 9 | 0 1 |
| | Two-spotted spider mite do. | Nymphs and adults do. | 1 1 | 200 | 1 1 | 100 |
| S | Celery leaf tier | Fourth instar | Much | 265 | 1 | 8 |
| | Pea aphid | 2-day-old nymphs | ı | 230 | 26 | ŧ |
| | Two-spotted spider mite | Nymphs and adults | 1 | 230 | ı | 06 |
| | do. | do. | 1 | 265 | 1 | 64 |
| 25 | Cabbage aphid | do. | 1 | 250 | 65 | 1 |
| | California oakworm | Fourth instar | Slight | 260 | ı | 21 |
| | Celery leaf tier | do. | op• | 235 | 1 | 92 |
| | | Nymphs | 1 | 200 | വ | 1 |
| | Two-spotted spider mite | Nymphs and adults | 1 | 265 | 1 | 97 |
| | do. | E 222 E | 3 | 250 | 1 | 100 |
| 25 | California oakworm | Fourth instar | Moderate | 230 | ı | 90 |
| | Celery leaf tier | do. | • op | 235 | 1 | 25 |
| | Large milkweed bug | Nymphs | 2 | 200 | ນ | 1 |
| | Pea aphid | 2-day-old nymphs | 1 | 215 | 86 | 1 |
| | Two-spotted spider mite | 2000 2000 2000 | 1 | 265 | 1 | 100 |
| | • op | Nymphs and adults | | 280 | 1 | 100 |
| | Celery leaf tier | Fourth instar | Much | 385 | 1 | 30 |
| | Large milkweed bug | Second-instar nymphs | | 220 | Ω | 1 |
| | Pea aphid | 2-day-old nymphs | 3 | 265 | 0 | 1 |
| | Two-spotted spider mite | Nymphs and adults | 1 | 340 | 1 | 100 |
| | • op | • op | 1 | 295 | ı | 100 |
| | | | | | | |

| Compound | | Insect | Stage | Feeding | Average deposit per square contineter | | Avorage kill after - 2 days 3 days | 1 . |
|---------------------------|---------|-------------------------|---------------------|----------|---|---------|--|-----|
| P d | Percent | 1t | | | Mi orograms | Percent | Percent | |
| onramide, N.N. | S | A myworm | Third instar | Much | 000 | 1 1 | 0 4 | |
| 7.4-dichloro- | | Green dock beetle | Fourth instar | do | 195 | ı | 79 | |
| | | Large milkweed bug | Third-instar nymphs | 8 | 230 | 0 | 8 | |
| | | Two-spotted spider mite | Nymphs and adults | 1 | 250 | 1 | 0 | |
| Frizemide, 2,4- | S | Аптумотт | Third instar | Moderate | 215 | 8 | 0 | |
| dichloro-11-e-hyl- | | Colery leaf tior | Fourth instar | Kuoh | 265 | 1 | 50 | |
| | | do. | Third instar | Moderate | 215 | 1 | 0 | |
| | | Pea aphid | 2-dey-old nymphs | ı | 220 | O | ı | |
| | | Two-spotted spider mite | Nymphs and adults | ı | 265 | ı | 381 | |
| | | · op | dos | ı | 325 | i | 100 | |
| Fencemide, 2,4- | 2 | Alder flea beetle | Third instar | Moderate | ಕು ಬ | 1 | 50 | - |
| dichloro-"- | | A rmy mo rea | do. | do. | 248 | 1 | 53 | 8 |
| isopropyl- | | Colory leaf tier | dc. | 900 | 248 | I | 약 | • |
| | | · op | Fourth instar | do. | 250 | 1 | 50 | |
| | | Pe aphid | 2-day-old nymphs | 1 | 220 | 0 | 1 | |
| | | Two-spotted spider mite | Nymphs and adults | 1 | 310 | ı | 95 | |
| | | do. | •op | 8 | 280 | 75 | ı | |
| Benzanide, 2,4- | S | Alder flee bootle | Third instar | Slight | 295 | , | 58 | |
| dichlero-1-propyl- | | Colory leaf tier | Fourth instar | Much | 295 | 1 | 63 | |
| | | Pea aphid | 2-day-old nymphs | ı | 250 | 36 | 1 | |
| | | Two-spotted spider mite | Mymphs and adults | ı | 250 | 1 | 100 | |
| | | ٠٠٥٥ | do. | 1 | 280 | ì | 84 | |
| Barranilido, 2-chl ro- 25 | 25 | Alder flew bootle | Third instar | Much | 82 82 | 1 | 0 | |
| 4'-nitro- | | Cattage aphid | Mymphs and achilta | 1 | 280 | 20 | 1 | |
| | | Colery leaf tinr | Fourth instar | Much | 310 | (8 | 6.7 | |
| | | For aphid | liyapha | | 3.0 | 96 | 1 | |
| | | Two-spotted apider mite | Nymph a and adults | 8 | 340 | 8 | ı | |
| | | | | | | | | |

| . 1 | | | | | | | | | | | | - | 9 | - | | | | | | | | | | | | | | |
|---|------------|-----------------------|------------------|----------------------|------------------|-------------------------|---------------------|------------------|---------------|----------------------|------------------|-------------------------|---|-------------------|-------------------|------------------|-----------|-------------------------|-----------------------|-------------------|------------------|--------------------|-------------------------|--------------------|----------------|--------------------|-------------------------|--------------------|
| age kill after - ys 3 days | الم | 12 | 41 | 1 | 1 | 0 | 1 | 1 | 29 | 1 | ^ | 32 | | 0 | 1 | નું | 8 | | 100 | 80 | 96 | 0 | 22 | 77 | 86 | 33 | 20 | 0 |
| Average kill after - 2 days 3 day | Percent | 1 | 1 | 10 | 20 | 1 | 100 | 42 | 1 | 0 |) in 1 day | 8 | | 1 | 13 | 3 | 26 | 83 | 3 | 1 | 1 | 1 | 8 | ı | 1 | | 1 | 1 |
| Average deposit per square centimeter | Micrograms | 295 | 280 | 170 | 230 | 265 | 250 | 250 | 230 | 185 | 230 40 | 200 | | 260 | 220 | 280 | 280 | 310 | 280 | 210 | 270 | 235 | 200 | 310 | 380 | 290 | 215 | 380 |
| Feeding | | Moderate | Much | 1 | 1 | 9 | None | Slight | Moderate | 1 | 1 | 1 | | Much | 8 | Moderate | 1 | 8 | None | • op | do. | ı | à | Moderate | do. | Much | 1 | Much |
| Stage | | Third instar | do. | Second-instar nymphs | 2-day-old nymphs | Nymphs and adults | Third instar | do. | Fourth instar | Second-instar nymphs | 1-day-old nymphs | Nymphs and adults | | Third instar | Nymphs and adults | Fourth instar | Nymphs | Nymphs and adults | Third instar | Fourth instar | do. | Nymphs | Nymphs and adults | Fourth instar | do. | do. | Nymphs and adults | Fourth instar |
| Insect | | Alder fles beetle | Celery leaf tier | Large milkweed bug | Pea aphid | Two-spotted spider mite | Armyworm | Celery leaf tier | do. | Large milkweed bug | Pea aphid | Two-spotted spider mite | | Alder flea beetle | Cabbage aphid | Celery leaf tier | Pea aphid | Two-spotted spider mite | Alder flea beetle | Armyworm | Celery leaf tier | Large milkweed bug | Two-spotted spider mite | Variegated cutworm | Аттучотт | Celery leaf tier | Two-spotted spider mite | Variegated cutworm |
| | Percent | 25 | | | | | ıo | | | | | | | 22 | | | | | 22 | | | | | | 22 | | | |
| Compound | | Benzanilide, 3, 4,41- | trichloro- | | | | Benzenasulfonamide, | 3,4-dichloro-N- | methyl- | | | | | m-Benzotoluide, | 2~chloro~ | | | | o-Chlorobenzoic acid, | 2-phenylhydrazide | | | | | Morpholine, 4- | (o-chlorobenzoyl)- | | |

Table 2. -- (Continued)

| | [دیـ | | - 10 - |
|--|-----------------|---|---|
| k4111 7 - 3 days | Porcon | 1000 | 11130 |
| Avcrage kill after - 2 days 3 days | Percent Percent | g 1 1 1 1 | 10811 |
| Avorage deposit Avcrage kill per square after - centimeter 2 days 3 days | Micrograms | 250 250 215 200 200 200 200 | 250 250 230 230 |
| Fooding | | Much do. Moderate | ф • 1 1 1 1 |
| Stage | | Fourth instar do. do. Nymphs and adults Fourth instar | do. 2-day-old nymphs Nymuhs and adults do. |
| Insect | 11 | 25 Armyworm do. Celery leaf ther Two-spotted spider mite Variegated cutworm | 25 Celery leaf ther Pea aphid Two-spotted spider mite do. do. |
| Compound | Percent | Piperidine, 1-(o-chlorobenzoyl)- | (p-chlorobenzoyl)- |

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| oonude | causir | Compounds causing from 25 to 74 percent | percent mortality of one or more species of insects fed dusted foliage | re species | of insects fed du | usted fo | liage |
|--|------------------------------|--|--|----------------------------|---|-------------------------|--------------------------------------|
| | | Insect | Stage | Feeding | Average deposit per square centimeter | Average kill after - | erage kill after - days 3 days |
| Percent | | | | | Micrograms | Percent | Percent |
| 25 Celery leaf Pea aphid Two-spotted | es aph | leaf tier id tted spider mite | Fourth instar Nymphs and adults do. | Much | 295 265 200 | 1 1 1 | 16 9 54 |
| 25 Celery leaf Pea aphid Two-spotted | elery ea aph wo-spo | leaf tier id tted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults | Moderate | 290 220 310 | 121 | 8 |
| 25 Armyworm Celery le Variegat | imywor elery ariegs | Armyworm Celery leaf tier Variegated cutworm | Fourth instar do. | Slight Moderate Much | 215 250 215 | | 33 13 13 |
| 25 Celery lea Large mill Pea aphid Two-spott | elery arge m | Celery leaf tier Large milkweed bug Pea aphid Two-spotted spider mite | Third instar Second-instar nymphs 2-day-old nymphs Nymphs and adults | Moderate | 280 170 250 230 | 1001 | 44 - 22 |
| 25 Armyworm Celery 1 Variegat | imywom elery l ariegat | Armyworm Celery leaf tier Variegated cutworm | Fourth instar do. | Moderate do. Much | 230 460 230 | 8 1 8 | α 44 α |
| 25 Cabbage aphid Celery leaf to Two-spotted specifical control of the Cabbage and Two-spotted specifical control of the Cabbage and Cabbag | abbage elery] | Cabbage aphid Celery leaf tier Two-spotted spider mite | Nymphs and adults Fourth instar Nymphs and adults | Moderate | 190 215 200 | 31 | 100 |
| 25 Cabbage aphid Celery leaf to Two-spotted sp | abbage elery] | Cabbage aphid Celery leaf tier Two-spotted spider mite | do. Fourth instar Nymphs and adults | Moderate | 265 295 295 | ω I I | 140 |
| 25 Celery les Pea aphid | ea aphi | Celery leaf tier Pea aphid | Fourth instar Nymphs and adults | Moderate | 265 250 | 1 1 | 58 |

| | اب | | | | | | | | - | - 12 | - | | | | | | | | | | | | | | |
|---|------------|------------------------------|------|---------------------|------------------|--------------------|----------------------|------------------|-------------------------|----------------------|------------------|------------------|-------------------------|-----------------|------------------|-------------------------|-----------------|------------------|-------------------------|-----------------|------------------|-------------------------|-----------------------|-------------------|-------------------------|
| age kill after - ye 3 days | Percent. | 33 | 8 | 39 | 54 | 50 | 17 | 1 | 00 | 1 | 1 | ı | 1 | 1 | 10 | 무합 무합 | 1 | 17 | 0 | 1 | 21 | 0 | 0 | 1 | 0 |
| average kill after - 2 days 3 day | Percent | 1 1 | ı | i | i | 1 | 1 | 5 | 1 | 0 | 15 | 200 | 0 | 503 | 1 | 1 | 20 | 1 | 1 | eriti eriti | 1 | 1 | 1 | 31 | ı |
| Avora e deposit per square centimeter | Micrograms | 230 | 230 | 340 | 430 | 340 | 230 | 260 | 200 | 250 | 250 | 165 | 325 | 250 | 250 | 310 | 310 | 265 | 265 | 200 | 330 | 250 | 265 | 237 | 200 |
| Fooding | | Moderate | · op | Slight | Moderate | Much | Moderate | ı | 1 | Moderate | do. | 1 | 1 | 1 | Moderate | 1 | 1 | Moderate | 1 | 1 | Moderate | 1 | Much | 1 | 1 |
| Stage | | Fourth instar | • op | do. | do | qc• | do. | 2-day-old nymphs | Nymphs and adults | Third instar | do. | 2-day-old nymphs | Nymphs and adults | Third instar | Fourth instar | Nymphs and adults | do. | Fourth instar | Nymphs and adults | cho. | Fourth instar | Mympha and adults | Fourth Lantur | 2-day-old nyrapha | Mympho and adulta |
| Insect | ıt | Armyworm Celery leaf tier | | A ITTO WYDITA | Celery leaf ther | Variegated cutworm | Celory leaf tier | Pea aphid | Two-spotted spider mite | Атлучот | Colory leaf tier | Pea aphid | Two-spotted spider mite | Cabbare a hid | Colory loaf tier | Two-spotted spider mite | Cabinge aphid | Colory leaf tier | Two-spotted apider mite | Cabbaro aphid | Calory lanf tier | Two-spotted spider nits | "olory loaf tior | Pon nohit | Two-spotted spider mite |
| | Percent | 25 | | 25 | | | 25 | | | 25 | | | | 25 | | | 25 | | | 25 | | | S | | |
| Compound | a | Benzamide, o-chloro- | | Benzamide, o-chlom- | N-propyl- | | Senzamide, p-chloro- | N-sec-hexyl- | | Benzamide, p-chloro- | N-1sobutyl- | | | Benzemide, 3.4- | dichloro-N.N- | diisobutyl- | Benzamide, 3,4- | dichloro-%- | 1sopropyl- | Benzanide, 3,4- | dichl ro-n- | - [£cc | Souranilido, 21-1:10- | Z,4-dishloro- | |

Table 3. - - (Continued)

| | | 000000000000000000000000000000000000000 | | DATE SOURCE | P P P P P P P P P P P P P P P P P P P | Average mili |
|--|--|--|----------------------|-------------------|---------------------------------------|--------------|
| Percent 25 Cel Two Two Two Two 25 Cel 25 Cel | | | 0 | centimeter | 2 days | 3 days |
| | | | | Micrograns | Percent | Percent |
| | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar Nymphs Nymphs and adults | Much | 370 265 355 | 26 | 9 1 1 |
| | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults | Moderate | 220 300 250 | 42 0 in 4 days | 2 1 E |
| 1 | Celeryleaf tier Pea aphid Two-spottod spider mito | Fourth instar Nymphs Nymphs and adults | Much | 250 265 220 | 104 | 9 8 1 |
| 25 Cel Pes Two | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults | Moderate | 340 265 265 | 161 | - 13 - |
| 5 CeJ | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults | Much | 265 280 265 | 1 8 1 | 010 |
| 25 Cel Pee Two | Celery leaf tier Poa aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults | Much | 260 250 235 | 26 0 in 4 days | 4.1 |
| 25 Cel Pee Two | Celery leaf tier Pea aphid Two-spotted spider mite | Third instar 2-day-old nymphs Nymphs and adults | Much | 265 230 250 | 1 4 1 | 010 |
| 25 Cel | Celery leaf tier Pea aphid Variegated cutworm | Fourth instar 2-day-old nymphs Third instar | Moderate Moderate | 240 220 295 | 1 to 1 | 010 |

| عيت المساد | | Insoct | | Stago | Feeding | Average deposit per square centimeter | Aver 2 da | after - ys 3 days |
|---|----------|---|----------------|--|----------|---|--------------|----------------------|
| hhe (| Percent | nt | | | | Micrograms | Percent | Purcent |
| countries ide, | S | Celery leaf tier Pea aphid Two-spotted spider | r der mite | Third instar Adults Nymphs and adults | Much | 210 215 215 | 100 | ⊙ I I |
| - 4-10 101 2.0- | Ω | Celery leaf ther Pea aphid Two-spot ed spidor | r dor mite | Fourth instar 2-day-old nyaphs Myaphs and alults | Much | 350 200 310 | 1 0 1 | 4 5 |
| | c3 ro | Colory leaf tier Foa aphid Two-spotted spider | der mite | Third instar Mymphs Nymphs and adults | Moderate | 230 280 265 | 106 | 29 11 |
| 7,1-Dishlorobenzoic e-id, 2-phenylhydra- zide | 52 | Telery leaf ther pea aphid | or der mite | Third instar 2-day-old nymphs Myaphs and alults | Moderate | 340 230 310 | 101 | 1 1 % |
| Piperidine, 2,4- Henloro azoyl- | S | Colory 1 af tier Pea aphid Two-spottod apider do. | r.der mits | Fourth instar 2-day-old-nyaphs Nyaphs and alults do. | Moderate | 200 • 265 230 250 | 1011 | 3.00 |

Table 4. - - Chlorinated benzamides that were found to be practically nontoxic, killing less than 25 percent of insects fed dusted foliage

| Compound | | Insect | Stage |
|---|---------|--|---|
| | Percent | | |
| Anthranilic acid, N- (2,4-dichloro- benzoyl)- | 5 | Armyworm Celery leaf tier Large milkweed bug Pea aphid Two-spotted spider mite | Third instar do. Third-instar nymphs 2-day-old nymphs Nymphs and adults |
| Benzamide, N-amyl- o-chloro- | 25 | Armyworm Celery leaf tier Large milkweed bug Two-spotted spider mite | Fourth instar do. Third-instar nymphs Nymphs and adults |
| Benzamide, N-amyl- p-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Third instar nymphs 2-day-old nymphs Nymphs and adults |
| Benzamide, N-amyl- 2,4-dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day old nymphs Nymphs and adults |
| Benzamide, N-benzyl- p-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzamide, N-benzyl- 2,4-dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzamide, N-sec-butyl- o-chloro- | 25 | Armyworm Celery leaf tier Variegated cutworm | Fourth instar do. do. |
| Benzamide, N-butyl- p-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzamide, N-sec-butyl- p-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzamide, N-butyl- 2,4-dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults |

Table 4. - - (Continued)

| Compound | | Insect | Stage |
|--|--------|---|--|
| I | ercent | | |
| Benzamide, N-sec-butyl- 2,4-dichloro- | 5 | Celery leaf ti Pea aphid Two-spotted sp | Fourth instar 2-day-old nymphs Eymphs and adults |
| Benzamide, p-chloro-X-2- bicyclohexyl- | 25 | Celery leaf ti Pea aphid Two-spotted sp | Fourth instar 2-day-old nymphs Hymphs and adults |
| Benzamide, p-chloro-N-cyclohexyl- | 25 | Celery leaf ti Pea aphid Two-spotted sp | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzamide, p-chloro-N-heptyl- | 25 | Celery leaf tip Pea aphid Two-spotted sp | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzamide, p-ahloro-N- propyl- | 25 | Celery leaf ti Pea aphid Two-spotted sp | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzemide, N.N-dibenzyl- o-ahloro- | 25 | Celery leaf tip Pea aphid Two-spotted sp | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzamide, N,N-dibenzyl- p-chloro- | 25 | Celery leaf time. Pea aphid Two-spotted spin | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzamide, N,N-dibenzyl- 3,4-dichloro- | 25 | Colory loaf tic Poa aphid Two-spotted sp: | Third instar 2-day-old nymphs Nymphs and adults |
| Benzamide, N,N-dibutyl- 2,4-dichloro- | 5 | Celery leaf tie Pea aphid Two-spotted sp: | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzamide, 2,4-dichloro-N-2-bicycloheryl- | 5 | Celery leaf tie Pea aphid Two-spotted sp | Third instar Adults Nymphs and adults |
| Benzamide, 2,4-dichloro-N- oyolohexyl. | 5 | Celery leaf tie Pea aphid Two-spotted sp: | Third instar 2-day-old nymphs Nymphs and adults |
| Benzamide, 3,4-dichloro-N- oyolo-hexyl- | 25 | Colory loaf tie Poa aphid Two-spotted sp | Fourth instar 2-day-old symphs Nymphs and adults |

Table. 4 - - (Continued)

| Compound | | Insect | Stage |
|---|--------|---|--|
| F | ercent | | |
| Benzamide, 2,4-dichloro- N-isobutyl- | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs • Nymphs and adults |
| Benzamide, 3,4-dichloro-N-isobutyl- | 25 | Cabbage aphid Celery leaf tier Two-spotted spider mit | do. Fourth instar e Nyaphs and adults |
| Benzanilide, 4'-benzoyl-4-chlore- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzanilide, 2'-bromo- 2,4-dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | Third instar 2-day-old nymphs Nymphs and adults |
| Benzanilide, 4'-bromo- 2-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar Nyaphs Nyaphs and adults |
| Benzanilide, 4'-bromo- 4-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs e All stages |
| Benzanilide, 4'-bromo- 2,4-dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | Third instar Adult Nymphs |
| Benzanilide, 4'-bromo- 3,4-dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs 6 Nymphs and adults |
| Benzanilide, 2-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Third instar Nymphs Nymphs and adults |
| Benzanilide, 2-chloro-2'- nitro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar Nymphs e Nymphs and adults |
| Benzanilide, 4-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs e Nymphs and adults |
| Benzanilide, 4-chloro-2'- nitro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs e Nymphs and adults |

Table 4. - - (Continued)

| | Compound | | Insect | Stage |
|----------------------------|---------------|---------|--|---|
| | 1 | Percent | | |
| Benzanilide, 3'-nitro- | 4-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzanilide, 4'-nitro- | 4-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzanilide, dichloro~ | 2,2 *** | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Third instar Nymphs Nymphs and adults |
| Benzanilide, dichloro- | 2,3- | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar Nymphs Nymphs and adults |
| Benzanilide, dichloro- | 2 1 , 4 | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old symphs Nymphs and adults |
| Benzamilide, dichloro- | 2,4- | 5 | Armyworm Celery leaf tier Green dock beetle Large milkweed bug Pea aphid Two-spotted spider mite | Third instar do. Fourth instar Third-instar nymphs 2-day-old nymphs Nymphs and adults |
| Benzanilide, dichloro-2 | | 5 | Celery leaf tier Pea aphid Two-spotted spider mite | Third instar 2-day-old nymphs Nymphs and adults |
| Benzanilide, dichloro-3 | | 5 | Celery leaf tier Pea aphid Two-spotted spider mite | Third instar 2-day-old nymphs Nymphs and adults |
| Benzanilide, | 2,4-dichloro- | 5 | Colory leaf tier Pea aphid Two-spotted spider mite | Third instar 2-day-old nymphs Nymphs and adults |
| benzanilide, 4'-phonylas | 2,4-dichloro- | 5 | Armyworm Celery leaf tier Creen dook beetle Large milkweed bug Pea aphid Two-spotted spider mite | Third instar do. Fourth instar Third-instar nymphs 2-day-olc nymphs hymphs and adults |

Table 4. - - (Continued)

| | Compound | | Insect | Stage |
|-----------------------------|---------------|--------|---|---|
| | F | ercent | | |
| Benzanilide, dichloro- | 31,4- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs • Nymphs and adults |
| Benzanilide, dichloro- | 4,41- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs e Nymphs and adults |
| Benzanilide, dichloro-4 | | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs e Nymphs and adults |
| Benzanilide, 2'-phenyl- | 2,4-dichloro- | 5 | Armyworm Celery leaf tier Green dock beetle Large milkweed bug Pea aphid Two-spotted spider mit | Third instar do. Fourth instar Third-instar nymphs 2-day-old nymphs Nymphs and adults |
| Benzanilide, tetrachlore | | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | Third instar 2-day-old nymphs e Nymphs and adults |
| Benzanilide, trichloro- | 2,21,4- | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | Third instar 2-day-old nymphs e Nymphs and adults |
| Benzanilide, trichloro- | 2,21,51- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar Nymphs e Nymphs and adults |
| Benzanilide, trichloro- | 21,3,4- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Third instar 2-day-old nymphs Nymphs and adults |
| Benzanilide, trichloro- | 2,31,4- | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | Third-instar 2-day-old nymphs Nymphs and adults |
| Benzanilide, trichloro- | 2,4,41= | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | Third instar 2-day-old nymphs Nymphs and adults |
| Benzanilide, trichloro- | 21,4,51- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs Nymphs and adults |

Table 4. - - (Continued)

| Compound | | Insect | Stage |
|---|--------|--|--|
| Pe | ercent | | |
| Benzanilide, 3,3',4- trichloro- | 25 | Colory leaf tier Pea aprid Two-spotted spider mite | Third instar 2-day-old nymphs Nymphs and adults |
| o-Benzaniside, 2-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs Hymphs and adults |
| p-Benzaniside, 2-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar Nymphs Hymphs and adults |
| p-Benzaniside, 4-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit Variegated cutworm | Fourth instar 2-day-old nymphs Nymphs and adults Third instar |
| o-Benzaniside, 2,4- dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider mit | do. Adults Nymphs and adults |
| p-Benzaniside, 3,4- dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old nymphs Nymphs and adults |
| Benzoic acid, 2,4- dichloro-, 2-phenylhydra- zide | 5 | Celery leaf tier Pea aphid Two-spotted spider mite | Fourth instar 2-day-old mymphs Nymphs and adults |
| o-Benzotoluide, 2-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar Nymphs Nymphs and adults |
| p-Benzotoluide, 2-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar Nymphs Nymphs and adults |
| n-Benzotoluide, 4-chloro- | 25 | Colory leaf tier Pea aphid Two-spotted spider mit | Fourth instar 2-day-old nymphs Nymphs and adults |
| o-Lenzotoluide, 4-chloro | 25 | Celery leaf tier Pea aphid Two-spotted spider mit- | Fourth instar 2-day-old nymphs Nymphs and adults |
| p-Penzetoluide, 4-chloro- | 25 | Celery leaf tier Pea aphid Two-spotted spider mit | Fourth instar Nymphs • Hymphs and adults |

Table 4. - - (Continued)

| Compound | | Insect | Stage |
|-----------------------------------|---------|---|---|
| | Percent | | |
| m-Benzotoluide, 2,4-dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider m | Third instar Adults aite Nymphs and adults |
| p-Benzotoluide, 2,4-dichloro- | 5 | Celery leaf tier Pea aphid Two-spotted spider m | Third instar Adults ite Nymphs and adults |
| Morpholine, 4- (p-chlorobenzoyl)- | 25 | Celery leaf tier Pea aphid Two-spotted spider m | Fourth instar Nymphs ite Nymphs and adults |
| Morpholine, 2,4-dichlorobenzoyl- | 5 | Celery leaf tier Pea aphid Two-spotted spider m | Fourth instar 2-day-old nymphs aite Nymphs and adults |
| Morpholine, 3,4- dichlorobenzoyl- | 25 | Celery leaf tier Pea aphid Two-spotted spider m | Third instar 2-day-old nymphs ite Nymphs and adults |

